USAFA/DFC

INTERACTIVE WEB PAGE DEVELOPMENT

ON-LINE HOMEWORK ASSIGNMENTS WITH AUTOMATED GRADING

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ABSTRACT

The Department of Chemistry, working with Dr Steven Gammon from the University of Idaho, has developed an interactive web-based system of assigning homework problems for our core and advanced chemistry classes. This system uses multiple choice questions that can be either text or numeric based. Students log in to the system individually and receive different problems and different versions of the same problem. Student scores are saved on the web server and are sent to the instructors.

This system has been operating for over a year now. We have found that students have the opportunity drill on basic chemistry concepts, and instructors have more time to prepare for classes while spending less time administering and grading standard quizzes and homework.

BACKGROUND

When Dr Steven Gammon arrived in June 1998 as a Distinguished Visiting Professor, he brought with him a web-based homework project he had been working on at the University of Idaho. The project used questions written in the .ASP format that interacted with Visual Basic dynamic link library files (.DLLs) that operated from a web server.

An attractive feature of this system is that a minimum amount of data was transmitted between the user and the web server, and all the question correcting, recording, and calculations were performed on the server. He was able to run this system at Idaho over a 1.44K modem. His goal at USAFA was to refine the system and test it on 1,200 cadets taking the Academy's core chemistry courses, Chemistry 141 and 142.

Dr Gammon worked with Capt Jim Blankenship, Capt Matt Sandelier, and Maj Ron Marks, who was the course director for Chemistry 141 and 142. Capt Blankenship assisted Dr Gammon with the majority of the system programming, while Capt Sandelier's primary job was administering the web server computers.

During the first semester of the project a Pentium-II 350 desktop computer running Windows NT 4.0 acted as the web server. Even though the computer was not designed as a server, the system ran well. When the project expanded to include the entire course, two dedicated server computers and more development tools were purchased with DF and IITA funding. This hardware has been more than adequate to handle the loads for online homework as well as course web pages for the chemistry department. With approval from the network configuration control board (CCB) two servers, named Gold and Argon, were approved to be listed on the USAFAnet domain name server.

HOW THE PAGES WORK

Questions used in the online homework system need to be written and saved to an HTML file. The interactive nature of the on-line homework questions requires that special symbols be inserted into the question files. Students reading and answering the questions do not see these symbols.

The computer application that presents questions to students, called the **question processor**,

distinguishes commands from normal text by reading special inserted symbols. Commands are prefaced and followed by these symbols, which are outlined below:

~ is found in header commands and question numbers
§ is used to designate answers to questions
| is used to insert explanations when students pick incorrect questions

Theoretically, questions can be written using Microsoft Word and saved as an HTML file. Experience has shown that Word sometimes inserts unwanted codes and scrambles graphics. Generating the questions in a dedicated HTML editor like FrontPage minimizes these problems.

Mathematical problems can be given and the question processor will evaluate a range of answers, providing incorrect choices along with the correct choice. Two students who get the same type of problem will not have the same correct answer.

FILE HEADER COMMANDS

The first commands the question processor reads occur in the question file **header**. These commands begin and end with the ~ character. The following list includes common header commands and their explanation:

~Questions= ~ This command tells the question processor how many questions in the file to give to the student. Question files often contain a many more files than the student will actually be assigned. For example, a file may contain twenty different questions, but the command ~Questions=10~ gives the students ten out of the twenty questions.

~Random~ The ~Random~ command scrambles the question order as well as the order of the answers within the questions.

~Force ~ ~Force ~ ensures that all students are given a specific question. If students are tested on ten questions out of twenty in a file, but all students were to see question #5, the command ~Force5~ needs to be in the header.

~*~ Tells the question processor that the header has ended and the questions are about to begin.

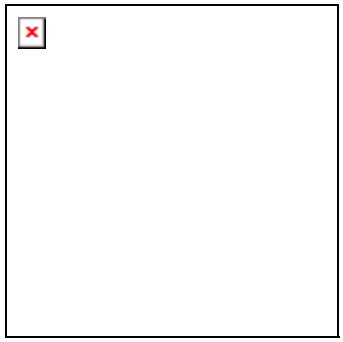
SAMPLE QUESTIONS

This section contains some sample questions showing how the formatting commands are applied.

Math question w/Picture in the question

~2c~

"The Haystack Observatory of the Massachusetts Institute of Technology (MIT) is an interdisciplinary research center engaged in radio astronomy, geodesy, atmospheric sciences, and radar applications. The major instrument at Haystack Observatory is the Haystack Radio Telescope, a 37-m-diameter radio telescope enclosed in a radome and used for astronomical observations at wavelengths from 2.6 mm to 1.3 cm as well as for wideband radar space surveillance and debris measurements at 3 cm."



Part of the HAYSTACK Radio Telescope System

Question: What is the frequency of the radar operating at §x=(2.6,13)§ millimeters? Use 2.998 X 10^8 m/s for the speed of electromagnetic radiation (light).

§Qend§

§Qexplanation=Information for this question was extracted from the Haystack radar web site: URL: http://fourier.haystack.mit.edu/haystack/general.html§

§Qweighting=3§

§Qremark=Frequency calculation. §

§Qunits=Hz§

§Qspread=(3,3,8)§

§#c=2.998E8§

§#y=1E-3§

§ceans= c/(x*y)§

§eans= c/x|Qhelp=You probably forgot to convert the wavelength from mm to meters.|§

~2c~

-

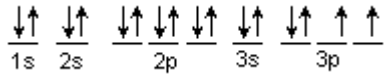
Text Question w/Pictures in the answers & custom responses for wrong answers

~4a~

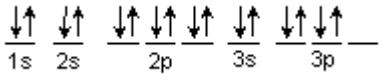
Which of the following is the correct orbital diagram for Sulfur?§Qend§

§Qweighting=3§

§Qremark=Orbital diagram.§

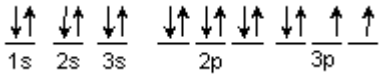
§ctans= 

§

§tans= 

|Qhelp=Orbitals fill singly before pairing.|§

§tans= none of them§

§tans= 

|Qhelp=Wrong orbital order.|§
~4a~

Math Question with Equations setting variables in the question

~9a~

§#x=(20,70)§

§#y=(0.03,0.1)§

§#l=1000§

§#z=(20,70)§

§#b=2§

§#c=100§

§#d=(1.0,1.5)§

§#p=278.1§

§#a=(25,50)§

Given the following reaction:

$$Pb(NO_3)_2\ (aq) + 2NaCl\ (aq) \rightarrow PbCl_2\ (s) + 2NaNO_3\ (aq)$$

If you react §EqnVar=x§ mL of a §EqnVar=y§ M $Pb(NO_3)_2$ solution with §EqnVar=z§ mL of a §EqnVar=((x*y*b*d)/z)§ M NaCl solution, and you isolate §EqnVar=(a*x*y*p/c)§ mg of $PbCl_2$, what is your percent yield? §Qend§

§Qremark=Percent Yield§

§Qspread=(5,5,10)§

§Qweighting=5§

§Qunits=%§

§ceans=a§

§eans=a*d§

§eans=a*b*d§

§eans=a*b§

~9a~

IMPLEMENTATION AND INSTRUCTOR IMPACT

In the Fall 2001 Chemistry 141, 14% of the course points were earned from web-based assignments. There were 15 weekly homework assignments, plus seven prelabs. The online homework system required cadets to constantly keep up with the class material or else risk losing the homework points. These regular assignments could also be given without increasing instructor grading workload.

The online assignment also gives cadets the opportunity for time management, as the assignments are open for grading over a period of five to seven days. The online homework server was easily able to handle inevitable increased load that occurs right before the assignment closes, but the same could not always be said for network hubs various parts of the cadet dormitories. Those cadets who did the assignment ahead of time did not have technical difficulties, while occasional problems were reported by cadets trying to access the system at the last minute.

The laboratory portion of the course also greatly benefited from the online prelab assignments. Cadets were required to look at the experiment background and procedures using an online quiz that was administered before they came to the laboratory. The chemistry 141 laboratory employed new experiments that used the entire two-hour block. If cadets had been less than prepared for these laboratories, the vast majority would never have completed the required work. Instead, cadets were challenged and they met and exceeded instructor expectations. There was no controlled study comparing online preparation vs. not using the online system. However, comparing course averages before and after online homework implementation, there was no statistically significant difference in student performance.

Course directors need to pay careful attention to the implementation of this new evaluating tool. Because instructor workload is minimized, the possibility exists for cadets to be overloaded with too many graded events. Also, while this system requires minimal work from most instructors, those department members tasked with implementing the online system have to transfer assignment scores and deal with day-to-day network problems.

CONCLUSIONS AND FUTURE WORK

The on line homework system was used in Chemistry 141 and 142 during the entire 2000-2001 academic year. Other chemistry courses are also starting to make use of this system. The Department of Chemistry will continue to use web-based homework into the foreseeable future. The technical development has slowed down, and department members are now fine tuning question content.

Future work will include templates and other aids that will make question writing easier. The question coding allows for great flexibility and power in writing questions, but it is also somewhat non intuitive. Rather than putting effort into adding more features to the software, we will work toward making the existing software easier to use for both the cadets and the instructors who maintain the system.

Finally, a major project could be based around quantitatively measuring the benefit of using the online homework system. The obvious results of using online homework are that instructors save time and cadets come to class, especially laboratories, better prepared. It would be rewarding to try to isolate the myriad variables associated with student learning and find a reliable figure expressing the benefit of the online homework system.